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THE SPREAD OF CRANBERRY FALSE BLOSSOM IN THE UNITED STATES

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CONTENTS

	Page
Introduction	1
The cranberry industry in the United States	2
Massachusetts	2
New Jersey	2
Wisconsin	2
Washington and Oregon	3
Less important areas	3
Varietal susceptibility	4
Status of false blossom	5
Massachusetts	5
New Jersey	5
Wisconsin	5
Washington and Oregon	6
Areas not known to be infested	6
Spread of false blossom	6
Wisconsin	6
Massachusetts	8
New Jersey	11
New York (Long Island)	12
Pacific coast	12
Factors that may have favored more rapid spread in recent years	14
Future policies	15
Insect control	15
Resistant varieties	16
Summary	17
Literature cited	17

INTRODUCTION

During the summer of 1929, the fact was established that false blossom [1] of the cranberry is readily transmitted by the leaf hopper *Euscelis striatulus* Fall (*11*).[2] Transmission experiments have been attempted with numerous other insects, but results have so far been negative. By 1929 also the disease had spread to such an extent as to include all but the most isolated cranberry-growing areas. It is evident, then, that there will be relatively little opportunity for further field study of its spread except very locally. From now on, false blossom takes its place among the well-established plant diseases. These facts, together with the present economic importance of this disease, seem to justify a statement of what is known regarding the history of its spread throughout the United States. While admittedly incomplete, the outline here given furnishes a detailed picture of the spread of a disease on a cultivated host. It gives, moreover, a chapter in the history of the cranberry industry in the United States.

[1] The conspicuous features of cranberry false blossom which may appear on different plants are a malformation of the flowers, replacement of the flowers by short branches with small leaves, a tendency of affected plants to produce weak, slender branches from usually latent axillary buds giving a witches'-broom effect, and excessive vegetative growth. The disease was described and illustrated by Shear in 1916 (*18*).

[2] Italic numbers in parenthesis refer to Literature Cited, p. 17.

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THE CRANBERRY INDUSTRY IN THE UNITED STATES

In order to make intelligible a discussion of the spread of false blossom in this country, it is necessary to outline briefly the extent of cranberry culture in the United States.

The cranberry of American commerce, *Vaccinium macrocarpon* Ait., is endemic in North America, its range extending from Newfoundland to North Carolina and west to Minnesota.

The chief cranberry-producing States are Massachusetts, New Jersey, and Wisconsin; next to these in importance are Washington and Oregon; and there are commercial bogs in Nova Scotia, Maine, Rhode Island, New York (Long Island), Michigan, and Virginia. With the exception of the bogs in Washington and Oregon the cranberry is grown commercially well within its natural range.

MASSACHUSETTS

About 60 per cent of the cranberry crop of the United States is produced in Massachusetts (*3*). The total area of cultivated cranberries in the State is approximately 14,000 acres, most of which is in Plymouth and Barnstable Counties. (Fig. 1.) All of the important horticultural varieties of cranberry grown in Massachusetts are selections of wild vines from native [3] bogs in the State. Approximately 50 per cent of the acreage is of the Early Black variety; about 33 per cent is Howes; and the balance is of the so-called odd varieties, some of which will be discussed later.

NEW JERSEY

According to a State survey made in 1921 (*9*), there were in New Jersey over 12,000 acres of cranberries, of which approximately one-half was classed as native Jersey vines; the rest were chiefly Howes, Early Black, Centennial, and Champion, arranged in the order of their importance. All of these named varieties are of Massachusetts origin. The total production for the year 1921 showed Howes, 32 per cent; native Jerseys, 29 per cent; and Early Black, 19 per cent.

WISCONSIN

There are approximately 2,000 acres of cultivated cranberries (*2*) in Wisconsin (fig. 2); of these, 1,700 were classed as full-bearing in 1929. Of the bearing areas, 900 acres (somewhat more than half) were classed as natives; that is, unselected or only partly selected native vines of various kinds. Next in commercial importance is the McFarlin, occupying a little over 300 acres. This, at present the most important named variety in Wisconsin, is of Massachusetts origin. Next in importance are the Searls and Bennett, both of Wisconsin origin, each with a little less than 200 acres in bearing in 1929. Berlin and Metallic Bell occupy less than 100 acres, while the Howes, which was of relatively little importance in Wisconsin in 1929, was being planted to the extent of 100 acres.

[3] The term "native" is in general use in the cranberry industry to designate unselected cranberry vines that have been brought under cultivation from wild bogs in the region in which they are grown.

WASHINGTON AND OREGON

While the cranberry bogs near the mouth of the Columbia River occupy areas which are similar in many respects, those on the Washington side of the river were planted chiefly with vines from Massachusetts, mostly brought in during the period from 1912 to 1915. The bogs on the Oregon side were planted in large part with vines from Wisconsin, chiefly Bennett, although there are Massachusetts vines on some of them.

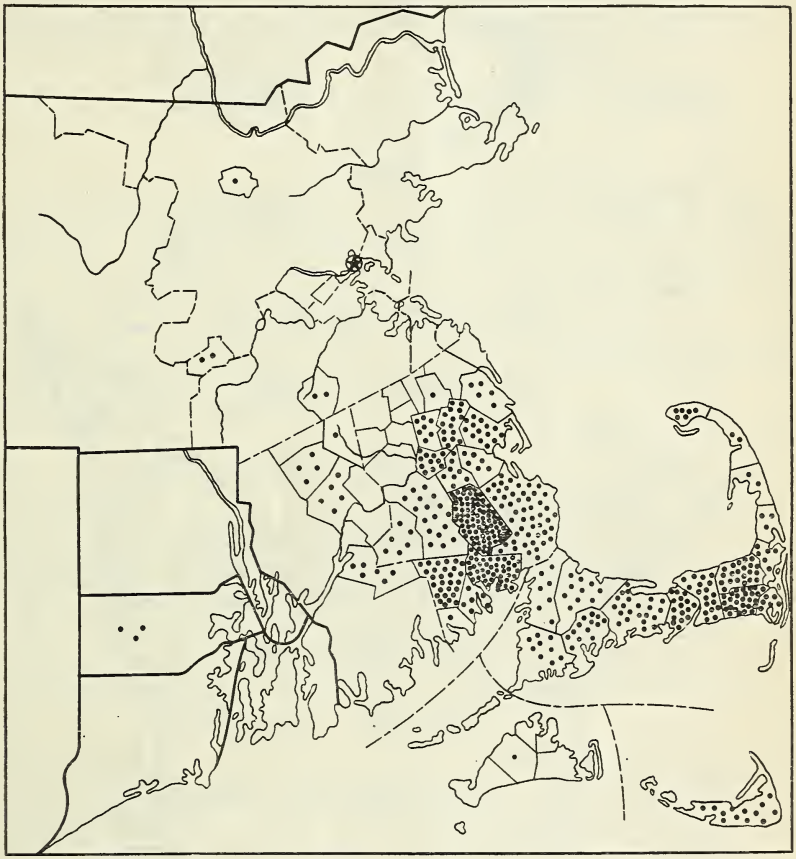

FIGURE 1.—Map showing cranberry-bog acreage in Massachusetts by towns. Each dot represents 25 acres

LESS IMPORTANT AREAS

The commercial bogs of Nova Scotia are planted, so far as the writer has been able to learn, with native cranberries.

The few cultivated cranberry bogs in Maine are planted with native berries or with Massachusetts varieties imported at least 35 or 40 years ago.

The cultivated cranberry bogs of Long Island, N. Y., are planted entirely with Massachusetts varieties, chiefly Early Black and Howes.

The bogs of Michigan are planted chiefly with native vines, although one at Alpena has an area of Howes taken from Massachusetts before 1918.

VARIETAL SUSCEPTIBILITY

The relative susceptibility of the different varieties of cranberry has apparently had so marked an effect on the amount and spread of false blossom that it may be well to summarize the information

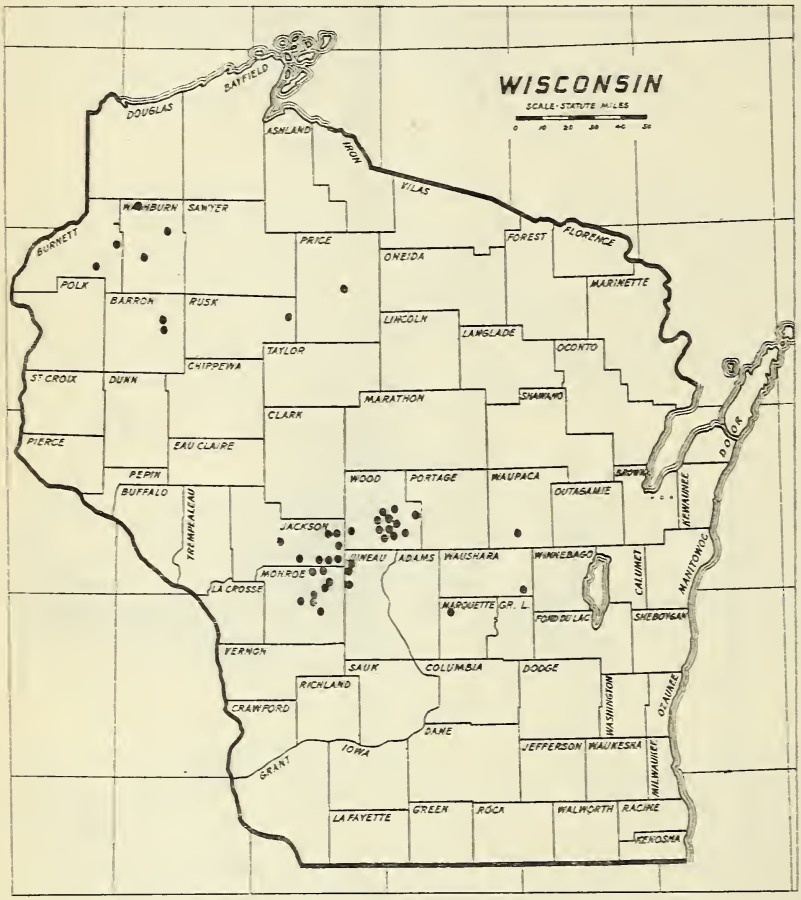

FIGURE 2.—Map showing location of cranberry bogs in Wisconsin. (Redrawn from Bain, *2*)

gained by field observations. There are some changes in this list as compared with earlier ones (*6*, *20*, *21*), and such lists must remain tentative and subject to revision.

Varieties very susceptible to false blossom: Howes, Centennial, Searls, Wales Henry, Berlin, Metallic Bell, Palmeter, and Prolific.

Varieties having some resistance to false blossom, but not sufficient to warrant being extensively planted: Bennett and Pride.

Variety showing a fair degree of resistance under varied field conditions: Early Black.

Variety showing marked resistance under varied field conditions: McFarlin.

Varieties not listed have not been observed extensively enough to permit a satisfactory diagnosis.

The extent to which the McFarlin is resistant to false blossom is well shown by a summary of conditions in Wisconsin. There are in this State between 300 and 400 acres of McFarlins belonging to 30 owners. On all but three of these areas some false blossom has been found, but on none has the disease ever become abundant. Usually it is necessary to hunt in order to find a plant with false blossom; yet the McFarlin has often been planted in places where other varieties have become unprofitable because of this disease and have been dug out, and frequently false blossom is severe in vines on adjoining sections.

STATUS OF FALSE BLOSSOM

MASSACHUSETTS

In Massachusetts false blossom is the most serious cranberry disease and its practical control one of the most serious cranberry problems. There is more or less infection on most of the bogs within the chief area of cultivation, including Nantucket and Marthas Vineyard. While within this area are occasional isolated bogs in which false blossom has not been found, the only groups of cultivated bogs in Massachusetts which may safely be considered free are those about Holliston and Lowell. These are the most northerly and westerly locations indicated on the map.

NEW JERSEY

In New Jersey the situation differs from that in Massachusetts chiefly in the presence of large areas of native vines on which it has not yet been practical to make a careful search for the disease. The larger bogs which contain Massachusetts vines are usually seriously infected with false blossom, and the native vines usually show some infection wherever they have been exposed to diseased vines. During the last two years false blossom has been found on many wild bogs well separated from other native or cultivated bogs.

WISCONSIN

The distribution of false blossom in Wisconsin is unique and can be understood only with reference to the distribution of the bogs (*2*, *pp. 7–8*). Considering the central cranberry district (Wood, Jackson, Monroe, and Juneau Counties) as a unit, false blossom is present almost everywhere and constitutes a steady but by no means decisive drain on the industry. In this region, according to the best-informed observers, the disease is increasing steadily (*2*, *p. 15*). In the group of bogs which includes the several properties in the north-central and northwestern parts of the State a quite different situation exists. In general these bogs, although largely planted with very susceptible varieties, have only a small amount of false blossom. The reasons for this condition are discussed in the section dealing with the history of false blossom in Wisconsin.

WASHINGTON AND OREGON

False-blossom conditions on the Pacific coast are well described by Bain, who spent four years studying cranberry diseases in this region (*1*, *p. 5*). He states:

> The false-blossom disease of the cranberry is present to some extent in practically all Pacific-coast bogs planted with Wisconsin vines, and has been found on the Bennett, Searls, and Prolific varieties. The writer has not found it on any Cape Cod or New Jersey varieties, even when the latter were planted adjacent to affected Wisconsin vines. * * * Berries frequently mature on affected plants, though they are dwarfed in size. Careful observation disclosed no evidence that the disease spreads under the conditions prevailing on the Pacific coast.
>
> The disease is no more prevalent on the whole in the oldest affected bogs in the region, however, than in those planted very recently, a fact that would be difficult to explain if the disease spread actively. Under Pacific coast conditions this disease at present exerts no appreciable influence on the yield.

AREAS NOT KNOWN TO BE INFESTED

False blossom has not been found on either wild or cultivated bogs in Nova Scotia, Maine, or Michigan, although a careful search has been made in these localities.

SPREAD OF FALSE BLOSSOM

The available evidence indicates that false blossom first appeared on cranberries in Wisconsin and from there spread to Massachusetts, New Jersey, and Oregon in shipments of infected vines. The disease has been carried also in vines from Massachusetts to New Jersey and Washington, and from New Jersey to Wisconsin. The spread from bog to bog within a given State was, in the past, chiefly by means of plantings of diseased vines; but with the increasing occurrence of the disease, it has apparently been spread by insects between bogs. Doubtless its spread by insects has always been the commonest means of distributing the disease over a single bog.

WISCONSIN

A published report of false blossom in Wisconsin was first made in 1908, but as explained in a later paper (*18*), it was recognized at that time that the disease had been present in Wisconsin for many years. Some of the older growers interviewed in 1925 believed that the disease was present on cultivated bogs at least as early as 1885. There is evidence, which will be presented herein that false blossom was present on vines shipped out of Wisconsin as early as 1895.

Attention was attracted to the disease as of commercial importance (*23*) in the Mather, Wis., region following the planting there, about 1900, of considerable areas of vines of the Palmeter, Berlin, and Metallic Bell varieties from the region about Berlin, Wis. By 1905 or 1906 false blossom had become prevalent in these varieties and since that time has become so severe that their cultivation has been materially reduced. It is significant that within this period the McFarlin, which is the only variety that is of proved high resistance to false blossom, became the most important named variety in Wisconsin, and the Bennett, which is able to produce a crop in the

presence of the disease but is more susceptible than the McFarlin, became the second named variety of importance, while the Berlin, Metallic Bell, and Palmeter have been so reduced as now to occupy only about 90 acres.

Whether false blossom was brought into the Mather region on the Berlin varieties or was present there and attracted attention because of its rapid spread on these varieties following their introduction probably can never be known, nor can the question of the source from which the disease reached the cranberry be even approximately guessed until some other host has been found.

Two things, however, appear to be fairly well established. False blossom is of relatively recent occurrence as compared with other cranberry diseases, if one may judge by the very much wider distribution of the known fungous diseases of the cranberry, such as rose bloom, end rot, and others. On the other hand, it has been present in Wisconsin for a considerable time, as is evidenced by its relatively wide distribution on wild bogs. Sawyer (*23*) in 1925 found it on wild bogs near Shell Lake and Spooner. One of these is several miles from the nearest cranberry bog, and both are well isolated from the center of greatest infection of false blossom.

In 1928 F. T. Eagan made a survey of wild cranberry bogs in northeastern Wisconsin and found false blossom on isolated bogs near Rhinelander, Woodruff, and Tomahawk on six different bogs. These are 30 or more miles from the nearest cultivated marshes and about 100 miles from any known false-blossom infection. Eagan also found an undoubted case of false blosssom on a plant of *Vaccinium oxycoccus* L., the first discovery of this disease on any host other than *V. macrocarpon*.

During the period from 1900 to 1920, while the Berlin, Metallic Bell, and Palmeter varieties became relatively less and less important in the Mather region, and the McFarlin and Bennett assumed a relatively predominant position in this area, the Searls, which is now known to be very susceptible to false blossom, was largely protected from the disease by its isolation. Although the Searls was discovered about 1893 in a wild marsh in Wood County, the largest plantings of this variety are chiefly in the northwestern part of the State, and until recently they were largely free from false blossom. Indeed, so complete was its isolation that in 1920 Fracker (*12*), then State entomologist, was able to report that no false blossom had been found on Searls in Wisconsin. The introduction of the disease into these northern areas is so recent that each step is known and should be recorded.

When the bogs of the Badger Cranberry Co., near Shell Lake were built a small area was planted with Bennett. On this area, which is located near the lower outlet gates, there has always been a small infection of false blossom. That the disease has not spread is an unusual example of the extent to which it can be checked in Wisconsin by adequate insect control. In the bog near McKenzie Lake, which, like the property of the Badger Cranberry Co., is chiefly planted to the Searls variety, a small section was planted with wild vines from a near-by bog. These wild vines were infected with the false-blossom disease when planted.

A bog near Minong, like the two just mentioned, was planted chiefly to Searls, but included a few acres of Metallic Bell and Prolific. Both these latter varieties showed false blossom and became unprofitable on account of its spread. The last of them were destroyed prior to 1927. False blossom is, however, slowly spreading in the Searls variety on this property despite continued efforts to rogue it out.

A bog near Cranberry Lake was planted with 80 acres of Searls. On these no false blossom had ever been found. Even Sawyer, in his careful survey made in 1925, could find no false blossom. In 1924, however, the company planted 5 acres of Howes vines from New Jersey. By 1926 these Howes vines had developed sufficiently to show that they were seriously infected with false blossom, and the next year the disease was found on some of the sections of Searls. By 1929 false blossom was rather common on Searls in different parts of the property.

The Wisconsin State Department of Agriculture was the first to attempt the control of the spread of false blossom. Beginning with 1915, the State nursery inspection office inspected and certified for sale only vines that were relatively free from false blossom. During the 10-year period following this they apparently succeeded in preventing the introduction of false-blossom vines into the northwestern section of the State. Indeed, when false blossom was finally introduced into cultivated bogs in this region it was (1) through planting infected vines coming from wild bogs and (2) through shipment of infected vines from another State. Fracker's statement (*12*). published in 1920, is interesting:

> Even though the cause may be a physiological one, plants from an infested bed continue to develop false blossom after being transferred to new locations. The loss usually then becomes greater from year to year, and total crop failure has sometimes resulted, followed by the abandonment of the bogs. Under these circumstances the nursery inspection office must adopt the same policy in providing for cases of false blossom as if the disease were proven to be of an infectious nature.

MASSACHUSETTS

That the history of the spread of false blossom is more complete in Massachusetts [4] than in any other State is due to a variety of causes—the relatively late introduction of diseased vines, well within the memory of men still active in cranberry work; the extraordinarily clean bogs, which have made it easy to detect even small infections of false blossom when the grower has become familiar with the disease; the fact that since 1916 a systematic record of the discovery of the disease in new bogs has been kept by the writer, who with the assistance of interested growers and others, has made historical notes of the shipment and planting of vines on bogs known to be diseased; and perhaps most important, H. J. Franklin's keen interest in any problem connected with the cranberry industry, even if not of evident commercial importance, for many of the notes on which this

[4] In preparing this résumé of the distribution and planting of vines affected with false blossom on Cape Cod it has been necessary, in order to make the record clear, to give in many cases the names of the owners of bogs on which diseased vines have been found or of persons who have planted diseased vines. It should be distinctly understood that no suggestion of blame is attached to selling or planting affected vines. At the time most of these transactions were made false blossom was not even suspected of being transmissible.

bulletin is based were made at the time when false blossom was not generally regarded as an economic problem.

The earliest plantings of Wisconsin vines in Massachusetts of which there is definite record were of the Berlin Bell variety. These were planted several years prior to 1900, probably about 1894 or 1895. These vines were planted chiefly in the region about Eagle Hill Stream, in Plymouth, and were planted on or transplanted to at least four bogs in that region—Eagle Hill, River, Haller, and Crowell bogs. The Wisconsin vines were removed from all of the bogs except Eagle Hill some time prior to 1929.

Part of the bogs in the Eagle Hill locality were built by the late George W. Ryder, of Chatham, who purchased some of the original shipment of vines and set them on a small bog in Chatham, Mass. These vines are still growing but have not borne a crop worth harvesting for many years. The scattering small berries still produced often show the bell shape characteristic of the Berlin variety. The fact that there are no dead areas in this bog, even after 35 years, gives evidence of the tenacity of life of vines infected with false blossom.

In 1914, when Shear (*18*) and Franklin (*13*) made a survey of false blossom in Carver, they found the disease present on five bogs. These were all Wisconsin vines, and the history of their introduction is briefly as follows: Between 1902 and 1904 a small quantity of cranberry vines was sent to A. P. Vaughn from Cranmoor, Wis., and the vines were planted by him on the Carver bog now belonging to Colburn Wood. These were known to be badly infected with false blossom. About 1904 James E. Vaughn and H. E. Lucas divided a barrel of Metallic Bell vines from Cranmoor. Vaughn planted his on the bog near East Carver now belonging to W. E. W. Vaughn, and Lucas planted his on the bog near East Carver now belonging to T. T. Vaughn. These vines are known to have been infected with false blossom, although on one of the bogs they produced a good crop the first year. About 1910 Seth Finney set Bennett and Bugle on his Sparrows Meadow bog near Darby. These vines are known to have been infected with false blossom. About 1910 also the A. D. Makepeace Co. planted Bennett in the Maple Spring bog near East Wareham. These are known to have been infected. About 1912 or 1913 Mr. Lucas reset on his present bog near East Carver some of the Metallic Bell from the bog now belonging to T. T. Vaughn. All of these vines were found infected in 1914 and were dug out between 1915 and 1917.

While the introduction made about 1895 may, in fact, not have been the earliest, there is no evidence that false blossom was introduced into Massachusetts prior to 1890. Vines even of very susceptible varieties sent from Massachusetts prior to that time and planted in isolated localities are uniformly free of the disease. Probably one of the very earliest bogs in Massachusetts to be infected with false blossom was that now known as the Harwich bog, near West Wareham. This is a very old bog, dating from about 1880. From this bog, at various dates, numerous sales of vines were made, notably of a variety locally known as Small's Number One, but considered by all authorities identical with the Mammoth or Holliston, which originated in the town of Holliston, Mass.

A rather extensive survey of false-blossom conditions in Plymouth County, Mass., in the fall of 1919, showed that this variety as grown in this section was generally infected with the disease. No less than eight bogs in various localities from Bryantville and South Hanson to Marthas Vineyard are known to have been set in part with diseased vines from this bog, yet when H. J. Franklin and the writer visited the cranberry bogs in the town of Holliston the same year it was impossible to find any false blossom, nor has the disease been found in any of the bogs in Holliston since. This condition led Doctor Franklin (*15*) to make the suggestion that the Holliston variety, as grown in Plymouth County, might really be a double one and mixed with the Bennett, and that the vines sold from the Harwich bog were either Bennett or a mixture of Bennett and Mammoth, the Bennett having been introduced from Wisconsin. Some confirmation of this suggestion is found in the fact that the owner, Emulous Small, was known to have been an intimate friend of at least one Wisconsin grower and to have been a member of the Wisconsin Cranberry Growers' Association.

A partial list of bogs in which vines were set from the Harwich bog and which are known to have been infected with false blossom as early as 1919 is given below. Next to the left margin are listed bogs to which vines were shipped directly from the Harwich bog; subordinate to these are listed bogs to which infected vines were carried from the bogs just above.

Name of bog	*Location*
Atwood Cranberry Co.	Carver, Mass.
Burrage bog.	South Hanson, Mass.
Bog formerly belonging to W. J. Nickerson.	Chatham, Mass.
Wenatuxet Cranberry Co.	Middleboro, Mass.
Clough bog.	Marthas Vineyard, Mass.
Company bog of John S. Howland.	Do.
Sandy Bottom bog.	Bryantville, Mass.
Bog on old Daniel Webster place.	Marshfield, Mass.
Fosterville bog.	South Hanson, Mass.
Lucas bog.	East Carver, Mass.
Vaughn bog.	Carver, Mass.
S. B. Gibbs bog.	South Carver, Mass.
Slocum-Gibbs Cranberry Co.	Carver and Middleboro, Mass.
Stepstone bog.	North Chatham, Mass.
Haines bog.	Near Chatsworth, N. J.

Until about 1924 false blossom was not generally regarded as of economic importance in Massachusetts. Prior to that time surveys were made because of the puzzling nature of the disease, because of its importance in Wisconsin, and because of interest in any cranberry problem. In 1914 Shear and Franklin knew of only five infected bogs and refer to the disease as "found to some extent," "found to a slight extent," and "a few scattering vines." In 1919 the writer found false blossom on a number of bogs in Bryantville and South Hanson and on several other bogs, in addition to those mentioned by Shear and Franklin, but it appeared to be of commercial importance on only about four or five. In 1924 the disease was known on 52 bogs. In 1929 it constituted the most important cranberry-disease problem in Massachusetts and there were few bogs in Plymouth or Barnstable Counties wholly free from this disease.

Of course, in each of these surveys some infected bogs were overlooked, but the increase has been marked, especially within the last six or seven years. This increase has been not only in the number of bogs known to be infected but in the amount of false blossom on bogs of which definite records had been made by the same observer in 1919 and 1929. Conspicuous examples are the bog at the head of Buttermilk Bay, the Pine Woods bog in South Carver, the bog of the Churchill Cranberry Co., the State bog at East Wareham, and numerous others.

If the rate of spread from the time of the several introductions (1895 to 1904) up to 1919 had been in any way comparable to the rate of spread in the decade from 1919 to 1929, the disease would certainly have attracted much attention long before 1919, nor could the idea have so long prevailed that the disease was not infectious but was due to cultural conditions (*16*).

NEW JERSEY

Information regarding the introduction and spread of false blossom in New Jersey is much less complete than in the other States.

False blossom was first found in New Jersey during the summer of 1915 at Whitesbog (Billy bog), on Bennett, brought from Wisconsin about 1909, and a little later on Centennial on the Big Swamp bog. At this time an attempt was made to eradicate the disease by mowing and burning diseased vines. This was later abandoned on account of the discovery of the disease in three or four widely separated locations on the same property. It is not certain that the planting of diseased vines from Wisconsin in 1909 marks the first introduction of false blossom into New Jersey. False blossom was also undoubtedly introduced on a bog near Chatsworth, N. J., in Mammoth vines from the Harwich bog in Massachusetts.

During the summers of 1915 and 1916 H. B. Scammell, then with the Bureau of Entomology of the United States Department of Agriculture and engaged in a study of cranberry insects in New Jersey, devoted some time to this disease. He found it in six different areas at Whitesbog and noted the abundance of aphids and of leaf hoppers in and near diseased vines. In 1916 Scammell resigned from that bureau to take up commercial cranberry growing, and no further work was done on false blossom in New Jersey for several years. Even as late as 1923 the disease was not regarded as a serious problem in New Jersey (*17*).

During the summer of 1924, however, the disease attracted sufficient interest in the region around Toms River for the writer to be invited to start field work at that point, and in 1925 a brief survey by C. S. Beckwith, of the New Jersey Agricultural Experiment Station, and the writer showed that false blossom was widely distributed in New Jersey, although in only a few cases had it become markedly destructive. The result of this survey is well summarized by Beckwith (*4*) as follows:

> False blossom has been causing some alarm through the cranberry growing regions of all of the cranberry states. Together with Dr. Stevens, of the Bureau of Plant Industry, we made a survey of this disease throughout the state. Forty-six bogs distributed all the way from Farmingdale to Port Norris were visited, and the presence or absence of the disease was noted. There was

one serious case of damage by this disease, two additional cases where it was bad enough to cause considerable worry and every bog of Howes or Early Blacks had some evidence of it. We did not find it at all on Jersey vines where there were no Howes or Early Blacks on the same bog, but it was present on Jersey when they were planted in the same bog with imported varieties. All of the evidence that we have points to the conclusion that the disease was carried in the cuttings that have been used in planting the bogs.

False blossom has now become very serious in New Jersey. The writer's observations in this State extend back only to the summer of 1924, but during the time that has elapsed since then the increase in false blossom has been marked and continuous, faster, if anything, than its progress in Massachusetts. The disease is now of major importance on almost all the large bogs as well as on many smaller ones.

NEW YORK (LONG ISLAND)

In September, 1930, R. B. Wilcox and J. L. Kelly, working in cooperation with representatives of the New York State department of agriculture and markets, found eight isolated plants or very small patches of cranberry vines affected with false-blossom disease on the largest and best managed cranberry property on Long Island, N. Y. The diseased vines were of the Howes and Matthews varieties. No vines from outside of Long Island had been planted on this property for at least 30 years. In fact, the only record of cranberry vines being brought to Long Island during recent years is of a few vines of the Early Black variety from Cape Cod, which were planted near Riverhead about 7 years ago. On only one other bog was false blossom found on Long Island. This was a small patch of vines near Calverton which was planted about 15 years ago from the large bog above mentioned.

Earlier surveys had failed to reveal the presence of false blossom on Long Island; however, the amount of the disease is so very small that it might easily have been missed. With the present evidence it is impossible to decide whether the introduction of the disease is recent or the spread of the disease has been unaccountably slow. This region will be carefully studied during the next few years for evidence of further spread of the disease.

PACIFIC COAST

As already noted, conditions on the Pacific coast are unique. The industry there is recent, having been developed largely since 1912. The Wisconsin vines planted there were undoubtedly affected, and the disease is still present. At least one carload of Howes and one consignment of McFarlin shipped to Washington were from infected bogs in Carver, Mass., yet in spite of its frequent introduction, false blossom has not spread appreciably in this region, as is evidenced by the report of Shear, who visited there in 1919 and 1924, and of Stevens, who visited there in 1920, 1922, and 1926, as well as of Bain (*1*), who worked there from 1922 to 1925. The reason for the failure to spread in Washington and Oregon may be due, in part, to the fact that the McFarlin, which is the most highly resistant to this disease of any known variety, is the one that is chiefly grown, but it is probably due mostly to the scarcity on the cranberry bogs of

the only leaf hopper which is known to carry the disease, *Euscelis striatulus*.

In the summers of 1925, 1926, and 1927, with the consent of the Bureau of Entomology and the assistance of State workers, a preliminary survey of leaf hoppers was made in Washington and Oregon and also in Wisconsin (*24*). The collection in Wisconsin was made by Sawyer (*23*) in 1925 and by Bain in 1926. In Washington and Oregon it was made by Bain in 1925 and by Bergman in 1927. The identifications were all made by D. M. DeLong. The results are summarized in Tables 1 and 2. So far as practicable in this collecting work, 50 sweeps of an 11-inch net were made on each bog visited.

TABLE 1.—*Leaf hoppers collected in Wisconsin during the summers of 1925 and 1926 on cranberry bogs apparently free from false blossom or known to be infected with it*

Species	Data from bogs infected with false blossom				Data from bogs apparently free from false blossom in 1925	
	Bogs visited		Leaf hoppers found		Bogs visited	Leaf hoppers found
	1925	1926	1925	1926		
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
Draeculacephala angulifera	14	13	212	42	10	240
Euscelis striatulus	14	13	95	13	10	5
Cicadula sexnotata	14	13	83	275	10	48
Euscelis instabilis	14	13	67	6	10	10
Aphelonema histrionica	14		33		10	46
Gypona octolineata	14		17		10	4
Philaenus parallelus	14		3		10	4
Platymetopius magdalensis	14	13	1	8	10	5
Euscelis exitiosus		13		53		
Peltonotus histrionicus		13		26		
Xestocephalus superbus		13		7		
Deltocephalus inimicus		13		5		
Deltocephalus unicoloratus		13		5		
Philaenus leucophthalmus var. fabricii		13		5		

TABLE 2.—*Leaf hoppers collected on cranberry bogs in Oregon and Washington during the summers of 1925 and 1927*

Species	Bogs visited		Leaf hoppers found	
	1925	1927	1925	1927
	Number	*Number*	*Number*	*Number*
Cicadula sexnotata	5	11	16	6
Draeculacephala mollipes	5	11	6	14
Thamnotettix fasciaticollis	5	11	5	2
Chlorotettix sp.	5		4	
Scaphoideus scalaris	5		4	
Thamnotettix sp.	5	11	1	19
Helochara communis		11		40
Deltocephalus sp.		11		2
Euscelis sp.		11		1

These surveys, of course, must be considered as only preliminary, but they present certain features which appear to be significant, notably the relative scarcity of leaf hoppers on the Pacific-coast bogs and apparent absence of *Euscelis striatulus* on these bogs.

The figures given in the tables fail to give any adequate idea of the actual difference in the relative abundance of leaf hoppers on cranberry bogs in the various States. Whereas the bogs listed in Wisconsin were visited only once, or at most twice, during the season, those in Washington and Oregon were visited five or six times each in 1925, and the figures given are the total collections for the time. These observations, together with the great abundance of *Euscelis striatulus* on the false-blossom bogs in Wisconsin and on many infected bogs in Massachusetts, led to the investigations being centered on this insect.

No strictly comparable figures are available for Massachusetts or New Jersey, but *Euscelis striatulus* is certainly vastly more abundant in these States than even in Wisconsin. The standard unit for comparison is 50 sweeps of an 11-inch net, and counts as high as 450 hoppers in 50 sweeps are by no means rare in New Jersey, whereas half this number is sometimes obtained in Massachusetts. Beckwith (*5*) reported in 1928:

> There are many species of leaf hoppers on the cranberry bogs, but the three most important in the order of number of individuals are the Blunt Nosed Leafhopper (Euscelis striatulus Fallen), the Sharp Nosed Leafhopper (Platymetopius frontalis, Van Duzee), and the Yellow Leafhopper (Thamnotettix smithi, Van Duzee).

On the basis of careful studies during the summers of 1928 and 1929, Beckwith and Hutton (*7*, *8*) state that in New Jersey *Euscelis striatulus* is "by far the most common leaf hopper on the bogs during the summer" and is "as a rule more abundant than all other species combined."

FACTORS THAT MAY HAVE FAVORED MORE RAPID SPREAD IN RECENT YEARS

All the available evidence indicates that false blossom has spread more rapidly during the last 5 or 10 years in Massachusetts and New Jersey than during the earlier period in these States (*22*) or during any known period in Wisconsin. The failure of the disease to spread in Washington and Oregon seems to be satisfactorily explained by the apparent absence of carriers in that region. This is the only region in which cranberries are cultivated outside their native range.

No doubt a part of the observed increase in the rate of spread of false blossom is nothing more than the natural geometrical increase resulting from a greater number of infected vines rendering viruliferous an ever-increasing number of insects which in turn infected new vines. The rate of spread in Massachusetts and New Jersey must soon decrease, because of lack of uninfected vines of highly susceptible varieties. On the other hand, several factors have combined to make the spread of false blossom more rapid during the last decade in Massachusetts and New Jersey than formerly.

First of these factors has been the tendency to plant Howes, Searls, or Pride, all very susceptible varieties, whenever bogs were rebuilt. For example, in 1921 there were in New Jersey about 650 acres of young vines; of these over 400 (almost two-thirds) were Howes. In Wisconsin, in 1929, of a total of 358 acres of young vines, 183 were Searls and 83 Howes, a total of 266 acres, three-fourths of the whole acreage of new vines.

About 1920 or 1921, with the return of more nearly normal labor conditions after the war, portions of many bogs were rebuilt and sanded. During more recent years increasing amounts of fertilizer have been used. All of these changes, highly desirable in themselves, favored the increase of new vine growth, which, in turn, is apparently favorable to leaf hoppers and to the spread of false blossom.

The change most important in its relation to the increase in the amount of false blossom is the difference in the method of handling the water. The studies of Franklin, Dobrosky, Beckwith, and Hutton have shown that the most favorable time for flooding to control hoppers is the latter part of June, too late, perhaps, for most effective fireworm control. During the spring of 1912 there was in Massachusetts marked and disastrous injury from flooding operations designed to control the black-headed fireworm. Following this there was much interest in problems of water injury. Bergman (*10*) and Franklin (*14*) published papers discussing the causes of water injury, and the present writer (*19*) proved that rot-producing fungi were spread by the June reflow. The result was a natural tendency to earlier flooding, which was safer for the plants, but no doubt less effective for hopper control.

Added to this is the ever-increasing accuracy of and confidence in the frost forecasts, which enable growers to protect their bogs from frost with the use of fewer reflows. Evidence that these changes in management have been important factors is found in two sets of field observations. In Massachusetts, at least, those growers who have habitually taken the greatest chances with late June reflows have had the least increase in false blossom.

That the progress of false blossom has been more rapid in Massachusetts and New Jersey than probably at any time in Wisconsin is explained not only by the greater number of leaf hoppers in the Eastern States but by the smaller number of varieties, the greater freedom from frost, and consequent less frequent reflowing.

FUTURE POLICIES

The preceding notes deal chiefly with the history of the spread of false blossom. On the other hand, the chief interest and the only utility of observations such as these is the possibility of their being used as a guide for the future. It may be worth while to review briefly the policies which seem to offer greatest promise for the immediate future.

INSECT CONTROL

Now that there is definite knowledge of the carrier of false blossom, vigorous control measures will be undertaken by many growers. These should greatly reduce the rate of spread. On the other hand, there appears to be nothing in the experience with attempts at control of other carriers of plant diseases of the virus type to indicate that this insect will be so reduced in numbers as to stop the spread of the disease on such susceptible varieties as Howes and Centennial.

However, in dealing with cranberry insects an unusual weapon is the ability to flood many bogs, and it is probably not too much to hope that more will be accomplished toward the effective control of the leaf hopper that carries false blossom than has been accomplished toward the control of any of the leaf hoppers that carry diseases of other crops.

For the more effective control of cranberry leaf hoppers by means of water more adequate knowledge of the limits of safety in flooding is needed, and present studies are being directed toward this end.

RESISTANT VARIETIES

The ideal solution, perhaps the only final solution, of such a situation as the present one is the discovery of varieties as good as or better than the present standard varieties, but which shall be resistant to false blossom. This will certainly be a long task, but it is by no means an impossible one. Growers will be fortunate indeed if a good substitute for the Howes variety can be secured.

Those associated in the study of cranberry problems are agreed, however, that no variety shall be offered to the industry merely because it is resistant to false blossom. Before a new variety can be worthy of serious consideration it must have attractive fruit, be a good vine, a consistent yielder, and be resistant not only to false blossom but to storage rots as well.

In view of recent experience, it is unlikely that the cranberry culture of the future will confine itself to as few varieties as in the past. It would seem desirable, merely as a policy of insurance in case of future epidemics, to maintain a continued interest in the selection and propagation of new varieties. The most promising places for the selection of new varieties appear to be the native bogs of Wisconsin and New Jersey. These cultivated areas often contain a variety of different types of berries, some of which are well known to be of superior worth. These will probably offer fruitful fields for selection for many years to come.

In view of the present uncertainty as to which of the standard varieties are best suited to planting, it would seem to be a wise policy for those charged with the management of large areas of native vines to bend their efforts toward bringing these areas into a high state of cultivation rather than replanting them with standard varieties. The rapidly developing canning industry may well offer a satisfactory means of disposing of such crops without placing them on the market in competition with standard varieties of proved value.

THE M'FARLIN VARIETY

One of the earliest observations regarding false blossom was that the McFarlin appeared to be resistant to the disease. This still appears to be true, both in Wisconsin and in Massachusetts. It is known that this variety is not immune, but at present it seems to be the most highly resistant of any now known. It seems, then, that one of the things to be done is to make a careful study of the growing and handling of this variety.

The faults usually charged against the McFarlin are the difficulty of proper scooping, its uneven size, its failure to color in storage,

and the fact that it must be left on the vines so late as to interfere with the most effective use of a fall reflow.

There seems to be no difficulty in harvesting the McFarlin by water raking. It is, of course, the most important named variety in Wisconsin at the present time. The picking machines now being used in increasing numbers are apparently able to handle McFarlin vines very well indeed. The difficulty caused by the uneven size of the berries can, of course, be reduced by grading the berries when packing.

There are undoubtedly differences in the keeping quality of the crops from different bogs, but observations for the last three years indicate that the variety deserves a very much better reputation for keeping quality than it has usually had. The McFarlin does not keep so well as the Howes (except perhaps in Oregon and Washington), but for the last three years, when comparable lots of Howes and McFarlin from Massachusetts, New Jersey, and Wisconsin have been kept under identical conditions of storage in Chicago, the McFarlin has shown up very well.

Failure to color in storage is a serious objection to a variety only when it is not possible to let the berries color on the vines. It is not important in berries to be canned, and for this new and important industry the McFarlin, because of its large size, tender skin, and fine eating quality, should be unsurpassed.

SUMMARY

In Wisconsin false blossom spread rapidly for a period after 1900, followed by only a gradual change in status in the central areas from 1910 to 1929 and by its introduction into the northern and north-central areas. At the present time the most careful observers believe the disease is spreading steadily.

In Massachusetts false blossom was introduced by at least five known shipments of vines between 1895 and 1910. The rate of spread was relatively slow up to 1919 but has been relatively rapid since that year.

In New Jersey the disease is known to have been introduced at least twice prior to 1909 and probably several times later, and it has spread very rapidly since 1924.

In Washington and Oregon the disease was introduced several times during 1912 and 1914 but has spread very little.

Possible factors which have apparently favored the more rapid spread of false blossom in recent years, especially in Massachusetts and New Jersey, are the replacing of native cranberries and other "odd varieties" by the Howes and other susceptible varieties, also the difference in the method of handling water, especially with reference to reflowing in June for the control of insects.

LITERATURE CITED

(1) BAIN, H. F.
1926. CRANBERRY DISEASE INVESTIGATIONS ON THE PACIFIC COAST. U. S. Dept. Agr. Bul. 1434, 29 p.

(2) ———
1929. CRANBERRY INDUSTRY IN WISCONSIN. Wis. Dept. Agr. Bul. 96, 15 p.

(3) BARBER, C. W.
1925. CRANBERRY ACREAGE AND PRODUCTION IN MASSACHUSETTS. 16 p., illus. (Mass. Dept. Agr., New England Crop Rptg. Serv.)

(4) BECKWITH, C. S.
1926. REPORT OF THE CRANBERRY SUBSTATION. Amer. Cranberry Growers' Assoc. Proc. Ann. Meeting 56: 14–18.
(5) ———
1928. REPORT OF THE CRANBERRY SUB-STATION. Amer. Cranberry Growers' Assoc. Proc. Ann. Meeting 58: 12–15.
(6) ———
1928. FALSE BLOSSOM. Amer. Cranberry Growers' Assoc. Proc. Ann. Conv. 59: 10–11.
(7) ——— and HUTTON, S. B.
1929. CRANBERRY FALSE BLOSSOM AND THE BLUNT-NOSED LEAFHOPPER. N. J. Agr. Expt. Sta. Bul. 491, 16 p., illus.
(8) ——— and HUTTON, S. B.
1929. LIFE HISTORY NOTES ON SOME LEAFHOPPERS THAT OCCUR ON NEW JERSEY CRANBERRY BOGS. Jour. N. Y. Ent. Soc. 37: 425–427.
(9) ——— and WEISS, H. B.
1922. A SURVEY OF THE CRANBERRY INDUSTRY OF NEW JERSEY. N. J. Dept. Agr. Circ. 45, 13 p., illus.
(10) BERGMAN, H. F.
1921. THE EFFECT OF CLOUDINESS ON THE OXYGEN CONTENT OF WATER AND ITS SIGNIFICANCE IN CRANBERRY CULTURE. Amer. Jour. Bot. 8: 50–58, illus.
(11) DOBROSKY, I. B.
1929. CRANBERRY FALSE-BLOSSOM DISEASE SPREAD BY A LEAFHOPPER. Science (n. s.) 70: 635.
(12) FRACKER, S. B.
1920. VARIETAL SUSCEPTIBILITY TO FALSE BLOSSOM IN CRANBERRIES. Phytopathology 10: 173–175.
(13) FRANKLIN, H. J.
1915. REPORT OF CRANBERRY SUBSTATION FOR 1914. Mass. Agr. Expt. Sta. Bul. 160, p. [91]–117.
(14) ———
1921. REPORT OF THE CRANBERRY STATION FOR 1919–1920. Mass. Agr. Expt. Sta. Bul. 206, p. 149–168.
(15) ———
1928. FALSE BLOSSOM. Wis. State Cranberry Growers' Assoc. Proc. Ann. Meeting 41: 10–17.
(16) JONES, L. R., and SHEAR, C. L.
1914. A REPORT UPON "FALSE BLOSSOM" AND OTHER CRANBERRY MALADIES. Wis. State Cranberry Growers' Assoc. Ann. Rpt. 27: 13–14.
(17) SCAMMELL, H. B.
1924. ADDRESS [ON CRANBERRY CULTURE]. Wis. Cranberry Growers' Assoc. Ann. Proc. 37: 34–43.
(18) SHEAR, C. L.
1916. FALSE BLOSSOM OF THE CULTIVATED CRANBERRY. U. S. Dept. Agr. Bul. 444, 8 p., illus.
(19) STEVENS, N. E.
1924. NOTES ON CRANBERRY FUNGI IN MASSACHUSETTS. Phytopathology 14: [101]–107.
(20) ———
1925. FIELD OBSERVATIONS ON FALSE BLOSSOM OF THE CULTIVATED CRANBERRY. Phytopathology 15: [85]–91.
(21) ———
1926. THE FALSE BLOSSOM SITUATION. Amer. Cranberry Growers' Assoc. Proc. Ann. Meeting 57: 20–26.
(22) ———
1928. THE FALSE BLOSSOM SITUATION IN 1928. Wis. State Cranberry Growers' Assoc. Proc. Ann. Meeting 42: 17–22.
(23) ——— and SAWYER, W. H., JR.
1926. THE DISTRIBUTION OF CRANBERRY FALSE BLOSSOM. Phytopathology 16: 223–227.
(24) TAYLOR, W. A.
1927. REPORT OF THE CHIEF OF THE BUREAU OF PLANT INDUSTRY. U. S. Dept. Agr., Bur. Plant Indus. Rpt., p. 4.

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